Effects of Prescribed Fire on Wintering Bark-foraging Birds

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Final Report

submitted by

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Introduction:

After nearly a century of fire suppression activities, forest managers are realizing the adverse effects of fire suppression on forest ecosystems. Many forests, including the ponderosa pine (*Pinus ponderosa*) forests in northern Arizona, have had fire as a natural component of the system until fire suppression. Restricting this natural component has led to unnatural forest conditions with increased fuel loads. In recent history, these unnatural forest conditions have led to large, destructive wildfires. As part of the National Fire Plan and Healthy Forests Initiative, forest managers are looking at alternate forest management strategies that include the use of prescribed fire to reduce the amount of fuel in the system.

Rocky Mountain Research Station is involved in the effort to examine fire effects on populations and habitats of wildlife in ponderosa pine forests in eight states across the western United States, as part of the Birds and Burns Network (BBN) (see Joint Fire Sciences Program, Proposal # *01-1-3-25: Prescribed fire strategies to restore wildlife habitat in ponderosa pine forests of the Interior West [Saab, Kotliar, Block]*). The goal of the project is to understand the ecological consequences of fire management for wildlife in ponderosa pine forests. The target wildlife species are cavity-nesting birds and songbirds. Cavity-nesting birds are a focus of this research because many of them depend on fire-maintained habitats for their dispersal and movements; they are designated as Management Indicator Species and Sensitive Species by state and federal agencies; and they are responsive to timber and fire management activities. Objectives of the study include evaluating the effects of fuel reduction on habitat and populations of avifauna.

I am investigating the effects of prescribed fire on wintering bark-foraging birds in the ponderosa pine forests of northern Arizona. Resident bark-foraging birds in the study area include hairy woodpeckers (*Picoides villosus*), white-breasted nuthatches (*Sitta carolinensis*), and pygmy nuthatches (*S. pygmaea*). Although the BBN focuses on breeding activities, it is also important to examine the effects of prescribed fire on wintering birds. Winter is a crucial time for birds, with food being a limiting factor. Since bark beetles have been known to increase activity in burned areas, they could become an increased food source for opportunistic bark-foraging birds. Therefore, an increase in bark-foraging bird density and change in foraging patterns in burn units after treatment with prescribed fire may be predicted.

Literature Review:

Prescribed burning- Fire is a frequent natural disturbance in ponderosa pine forests of northern Arizona (Covington and Moore 1994b). Before Euro-American settlement, these forests were considered to be open and park-like (Covington and Moore 1994a). Fires occurred every 2 to 12 years, maintaining an open canopy structure and a variable, patchy tree distribution (Moir et al. 1997). In the past 100 years, fire suppression has led to many forest management problems, including increased disease, insect infestation, and parasites, increased fuel loading, and increased severity and destructive potential of wildfires (Covington and Moore 1994b, McCullough et al. 1998).

Today, there is a general understanding that some fires can be beneficial to the landscape and that complete fire exclusion is not a sustainable course of action (Bradley and Tueller 2001). State, federal, and local agencies put enormous resources into efforts to reduce fire occurrence while at the same time advocating the need to use fire to promote healthy ecosystems (SNEP 1996). The challenge faced is how to restore some aspects of a more natural fire regime while minimizing the threat of wildfire (SNEP 1996). Prescribed fire is frequently advocated as a tool that can be used for landscape level fuel reduction while simultaneously restoring fire as an ecosystem process (McKelvey et al. 1996).

Bark beetle response to burns- Bark beetles are attracted to areas after fire. Bark beetles that are attracted to fire injured ponderosa pine are the western pine beetle (*Dendroctonus brevicomis*), mountain pine beetle, (*D. ponderosae*), pine engraver beetle (*Ips* spp.) and red turpentine beetle (*D. valens*) (Flanagan 1996). Miller and Patterson (1927) first reported the direct relationship between fire injury and subsequent insect damage on burned-over areas. Trees with scorched trunks or crowns can become susceptible to bark beetles, depending on the severity and pattern of scorching (Ferrell 1996, McCullough et al. 1998, Bradley and Tueller 2001). Ponderosa pines with heavy crown scorch tend to be more heavily colonized by bark beetles (Wallin et al. 2003, McHugh et al. 2003).

Bark beetle infestations may be a serious problem especially following the initial reintroduction of fire into stands with high fuel levels due to long term fire exclusion (Ferrell 1996). An increase in the number of trees infested by bark beetles is a frequent aftermath of so-called "light" fires, which rarely kill mature trees (Miller and Patterson 1927). Machmer (2002) and Bradley and Tueller (2001) reported an increase in the abundance of bark beetle and wood borers after prescribed fire. Understanding the ecology of fire-insect interactions is needed as we identify strategies to manage forest pests, enhance forest health, and maintain biological diversity in forest ecosystems (McCullough et al. 1998).

Woodpecker response to bark beetles- Information on the effects of fire on birds in southwestern ponderosa pine forests indicates that several species benefit from disturbance. Woodpeckers apparently follow the bark beetle food source and tend to increase in number after fire (Brawn et al. 2001). Birds tend to be opportunistic foragers and often make use of super-abundant food resources (Szaro et al. 1990). As prey density increases, predators can respond functionally by attacking more prey or numerically by aggregating or having increased survival rates (Garton 1979, Kroll and Fleet 1979, Machmer and Steeger 1995). Therefore, it is intuitive that bark-foraging birds will aggregate in areas with increased bark beetle activity, being among the most important predators of these insects (Jackson 1979).

A review by Crockett and Hansley (1978) on woodpecker response to bark beetle outbreaks concluded that hairy woodpeckers respond to bark beetle outbreaks, increases in woodpecker populations are most significant during the non-breeding season, and bark beetle adults and larvae form the major winter food source for woodpeckers. Beal (1911) and Otvos (1965) reported that hairy woodpeckers feed primarily on bark beetles and wood borers in winter and appear to be opportunistic feeders, shifting about in large

numbers in winter in search of food and shelter. Although woodpecker response to bark beetle outbreaks has been widely studied, literature on the response by other bark-foraging species, such as pygmy and white-breasted nuthatches, is not currently available.

Avian foraging patterns in winter- Seasonal changes in availability of woodpecker food items might be expected to cause concurrent changes in foraging methods (Conner 1979, Szaro et al. 1990). During winter, hairy woodpeckers use methods that penetrate trees deeper, such as scaling bark and excavating, than during milder seasons (Conner 1979). Woodpeckers use subsurface foraging techniques to penetrate the subcambium layer where beetle larvae are extracted (Machmer and Steeger 1995). Bark scaling by woodpeckers also tends to make food more available to other bark foragers, such as brown creepers (Otvos 1979). Nuthatches and creepers use superficial foraging techniques to chip away bark flakes, locating insect prey on or near the bark surface (Stallcup 1968, Machmer and Steeger 1995).

Although these birds all use bark as a foraging substrate, investigations by Stallcup (1968) reveal that each species is segregated spatially and temporally, allowing these birds to coexist in the same region with reduced or no interspecific competition for food. In a study by McEllin (1979), white-breasted nuthatches had lower mean foraging heights than pygmy nuthatches during the non-reproductive season. Also, white-breasted nuthatches used a significantly smaller proportion of the vertical height during the non-reproductive period than did the pygmy nuthatches (McEllin 1979). McEllin (1979) additionally found that white-breasted nuthatches maintained an exclusivity strategy throughout the entire year through territorial defense, whereas pygmy nuthatches exhibited an inclusivity strategy in which tolerance and, possibly, cooperation resulted in group utilization of habitat space. This information suggests that several species of bark-foraging birds can make use of the same food source without much competition.

Questions:

1) *Will there be a greater presence of bark beetles in units treated with prescribed fire than untreated units?*

Method of investigation: tree and bark beetle survey

2) *Will the density of bark-foraging birds be greater in units treated with prescribed fire than untreated units?*

Method of investigation: distance sampling

3) *If there is increased bark beetle activity in burned areas, will this have an effect on bark-foraging birds' foraging behaviors?*

Method of investigation: foraging observations

Study site description:

This study is providing information on the response of bark-foraging birds to prescribed burns in the ponderosa pine forests of the southwest. Research was conducted on Birds and Burns Network study sites in northern Arizona. These study sites are located in the Coconino (COAZ) and Kaibab (KAAZ) National Forests, 60 km southeast and 35 km northwest of Flagstaff, respectively. Each study site has control and burn treatment units. Having two study sites provides replicates for each burn treatment and control. Prescribed burns occurred on the Coconino treatment unit (Imax) during Fall 2003 and on the Kaibab treatment unit (Kendrick) during Fall 2003 and Spring 2004. Treatment units were chosen in consultation with district fire managers on each forest. Control units were then placed in representative areas within 1 km of the treatment unit where no management was planned by the forests. The point count stations were assigned using a GIS algorithm, randomizing the placement of the first station.

Study Site	Unit	Treatment	Area (ha)	No. stations	Dates burned
KAAZ	Kendrick	Burn	369	40	10/27/03, 11/6/03, 3/25/04
KAAZ	Moritz	Control	360	40	NA
KAAZ	Beale	Control	127	10	NA
COAZ	Imax	Burn	405	40	9/15/03, 9/18/03, 9/19/03
COAZ	Buck Mtn	Control	404	40	NA

Table 1. Study unit descriptions and treatment dates.

Overstory vegetation on each of the three Kaibab study units is dominated by ponderosa pine. Pinyon pine (*P. edulis*) and one-seed (*Juniperus monosperma*) and alligatorbark (*J. deppeana*) juniper occur on the control units, but contribute little to stand canopies. The overstory on the two Coconino study units is also dominated by ponderosa pine with Gambel oak (*Quercus gambelii*) also contributing to canopy structure. Alligatorbark juniper is also found on the Coconino units. Open grassland patches on both sites tend to be dominated by bunchgrass species, including Arizona fescue (*Festuca arizonica*) and blue gramma (*Bouteloua gracilis*). The topography on the Kaibab is flat, with elevations ranging from 2100 to 2300m. Topography on the Coconino varies from flat to steep hills, with elevations ranging from 2070m to 2160m. Historical timber harvest activities have added to forest fuels in the form of downed pole-size trees, stumps, and slash debris. Fuels in these forms, however, are sparse and relatively even in their distribution across each unit.

Methods and Materials:

Bird surveys- I measured avian densities in each unit using distance sampling (Buckland et al. 1993). Distance sampling is considered superior to traditional point count methods in estimating bird densities (Rosenstock et al. 2002, Norvell et al. 2003). Each unit will have transects connecting 40 point count stations, each approximately 300m apart and at least 200m from unit edges (see Appendix A, Figure 1 for diagram). At each station, I recorded distance (using categories up to 100m) and direction to all birds observed during the 5-minute survey period. The number of individuals, sex (if

known), and type of detection were recorded. Point counts began within 30 minutes after dawn and were concluded within 5 hours. I visited each station four times between mid-October and mid-March. Distance sampling and foraging observations occurred during separate visits to each station.

Foraging observations- I conducted foraging observations of my target species (hairy woodpecker, white-breasted and pygmy nuthatches) from mid-October until mid-March. I searched the area within a 100m radius of the point count stations for foraging birds for 8 minutes. If a flock was located, I used a random number table to determine the individual for observation. The first number indicated the species (if in a mixed species flock) and the second number indicated the individual from the "noon" bird following a clockwise direction. Once a bird was located, I watched the bird for 10 seconds, but recorded no data. This period of time was to allow the bird to resume "normal" activity patterns after being disturbed and also prevented only recording conspicuous behavior (Noon and Block 1990). After the initial 10 seconds, I recorded the first foraging event observed. The use of an initial observation, rather than sequential observations, assures independence of observations that is best for statistical analysis (Hejl et al. 1990). Then, I recorded the foraging location using a GPS unit and recorded data relating to the foraging activity (i.e. foraging act, such as peck, prone or flake; surface; and height) and tree (same as fire injury and bark beetle survey). Only one foraging observation per individual bird occurred per day. All stations had equal observation effort throughout the season. Foraging observations and distance sampling occurred during separate visits to each station.

Fire injury and bark beetle surveys- I conducted fire injury surveys using 10m radius plots at each point count station. Four plots were assigned: one at the station center and three within 100m of the station center. To find the locations of the additional plots, I assigned one a random bearing and distance from the station center, using a random number table. The other two plots were offset from the first by 120 and 240 degrees, respectively, and were assigned distances from a random number table (see Appendix A, Figure 2). All trees over 12.7cm dbh in each plot were marked with aluminum tags and numbered, and plot centers recorded with a GPS unit. I recorded the following information about each marked tree: dbh (to 0.1cm), height (to 0.5m), high and low bole char heights (to 0.5m), bole char severity (N=none; L=light char on bark edges; M=bark uniformly black, some inner fissures not charred; H=bark deeply charred), percent bole charred at base, pre-burn crown ratio (crown length/tree height), and crown volume burned (percent green, brown, and black) (USDI NPS Fire Monitoring Handbook 2003).

I also determined the presence or absence of bark beetles per marked tree by noting evidence of bark beetle activity (i.e. pitch tubes, frass and boring dust, and fading needles) and woodpecker foraging (i.e. bark flaking, drilling holes). Bark beetle surveys occurred in the plots both seasons, while fire injury surveys were only conducted in 2004.

Summary of data collected and initial analysis:

- Question #1) *Will there be a greater presence of bark beetles in units treated with prescribed fire than untreated units?*

Tree and bark beetle survey

Tree data collected Fall 2004 and Spring 2005.

Total number of trees observed:
Control = 2439 (PIPO = 2097)   Burn = 2699 (PIPO = 2320)

1st round of beetle data collected Fall 2004 and Spring 2005.
2nd round of beetle data collected Fall 2005 – looking for new attacks.

Total percentage of PIPO trees showing signs of bark beetle activity:
Year 1: 8.9% in Burn, 4.1% in Control
Year 2: 12.2% in Burn, 5.6% in Control

Completed: Surveys completed Nov 2005, all tree data entered into Excel, 1st round of beetle data entered into Excel.
Still to be done: enter 2nd round beetle data into Excel, check data entry for errors, and data analysis.

- Question #2) *Will the density of bark-foraging birds be greater in units treated with prescribed fire than untreated units?*

Distance Sampling

Initial results:

Density (per 100 ha)

	Control	Burn	
WBNU	1.08	1.02	N=406 (209C, 197B)
PYNU	3.71	3.44	N=678 (337C, 341B)
HAWO	0.24	1.13	N=160 (47C, 113B)

Completed: Four rounds of point counts completed each season between Oct. and March, all data entered into Excel, checked for errors, exported into Distance 5.0, initial analysis has begun.
Still to be done: final data analysis in Distance 5.0.

- Question #3) *If there is increased bark beetle activity in burned areas, will this have an effect on bark-foraging birds' foraging behaviors?*

Foraging Observations

Total number of foraging observations

2004-05

	Control				Burn			ALL
	Moritz	Beale	Buck Mtn	**Total**	Kendrick	IMAX	**Total**	Total
WBNU	1	1	8	**10**	2	6	**8**	18
PYNU	3	0	0	**3**	5	3	**8**	11
HAWO	4	1	0	**5**	11	0	**11**	16

2005-06

	Control				Burn			ALL
	Moritz	Beale	Buck Mtn	**Total**	Kendrick	IMAX	**Total**	Total
WBNU	14	9	53	**76**	17	68	**85**	161
PYNU	29	14	23	**66**	31	33	**64**	130
HAWO	13	2	15	**30**	38	21	**59**	89

-higher numbers in 2005-06 due to increased effort this season (help from nice weather and a field tech)

Completed: Foraging observations completed March 2006, all data entered into Excel and checked for errors.
Still to be done: data analysis.

Conclusions:

Initial results from this study indicate that prescribed fire has an effect on wintering, bark-foraging birds. Bark beetle presence increased on the units treated with prescribed fire, however, bark beetle outbreaks did not occur. This increase in bark beetle presence may provide an additional food source for bark-foraging birds in winter, while food is generally scarce. With an additional food source in the burned units, one would expect a similar response in bark-foraging bird density. However, of the three species observed, only hairy woodpeckers had a significantly greater density in the burned units. The nuthatches are known to make use of other food sources in winter, such as cached seeds (Kingery and Ghalambor 2001, Pradosudov and Grubb 1993), and therefore may not utilize bark beetles during this time. Although not analyzed yet, the foraging data collected is expected to support these conclusions.

Prescribed fire use by forest managers may have a positive effect on hairy woodpeckers wintering in ponderosa pine forests of northern Arizona. Bark beetles increase in areas treated with prescribed fire, creating an additional food source in winter. This additional food source leads to an greater density of hairy woodpeckers in the burned areas. Nuthatches, not utilizing this food source, had similar densities in burned and unburned areas. Therefore, forest managers can employ the use of prescribed fire without detriment to bark-foraging birds in northern Arizona.

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